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Hybrid Electric Vehicle Drive Control

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Abstract

The engine drive system is used in the hybrid electric vehicle, and meanwhile the direct motor drive system is used in it. The engine and the electric motor compose the mix dynamic system to actuate the vehicles travel together, causing the noxious gas in vehicles' fuel consumption and the waste gas discharges to reduce massively. This article analyzes Hybrid electric vehicle's merits, the major technique unit, the engine and electric motor's combination way. Also, it analyzes the tandem Hybrid electric vehicle, the parallel Hybrid electric vehicle, the compound connection type Hybrid electric vehicle's actuation pattern. Hybrid electric vehicle using the engine and the electric motor supplementary working pattern can make the engine to be in the best working condition throughout.

Key word: Hybrid electric vehicle; Actuation pattern; Engine; Motor

1 Introduction

There are three types of electric vehicle: the battery electric vehicle, the fuel cell electric vehicle and the hybrid electric vehicle. The high energy battery is the key technology of developing the battery electric vehicle. At present, the electric vehicle has a heavy battery, a big volume and a short driving range. It also needs a large area to build facilities for testing and charging. Therefore, it is difficult for local authorities, enterprises and user to accept it. Fuel cell, although with bright future, is very expensive, and the construction investment is very big. China can just make a few trials. Hybrid electric vehicle (HEV) is a vehicle type between the internal combustion engine vehicle and the electric vehicle. It is a transitional type from an internal combustion engine vehicle to the electric vehicle.

The hybrid electric vehicle displays the long engine operating time, the strong power, a free pollution of the motor, and the low noise, with over 10% of increased thermal efficiency and over 30% of improved exhaust gas emission.

2 The advantages of the hybrid electric vehicle

(1) Oil consumption is low, the emissions pollution is less

The engine drive system is used in the hybrid electric vehicle, and meanwhile the direct motor drive system is used in it. The engine and the electric motor compose the mix dynamic system to actuate the vehicles travel together, causing the noxious gas in vehicles' fuel consumption and the waste gas discharges to reduce massively. At present, for the hybrid electric passenger vehicle (equal to ordinary passenger vehicle and intermediate passenger vehicle) the fuel consumption is about 3L/100km. The noxious gas discharged in the waste gas achieves the goal of “the ultra low pollution” the emissions request, which meets the standard of the 21st century initial period HEV goal.

Engine's power in HEV is smaller than generally the same rank internal combustion engine vehicle, but meets a higher request of the fuel consumption and exhaust gas emission pollution. Besides, the vehicle adopts the modern newest technology to make the engine to be under the efficiency highest condition to revolve frequently, displaying electric motor's low speed big torque characteristic fully and causing the engine avoid the bad conditions when starting,

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accelerating and climbing, which are the HEV main features.

(2) Compared with the battery electric vehicle, the hybrid electric vehicle does not need to build the ground charge facility.

Compared with the battery electric vehicle, the available conventional internal combustion engine generates the power, together with the battery, the motor-driven hybrid electric vehicle, after filling the oil and the electricity, can travel about 500~1000 kilometers. Hybrid electric drive vehicles in movement, launch function to battery unit supplement electrical energy, therefore, does not need to look like the electric vehicle(storage battery vehicle), stands still in the garage (or charge stand) in the flowered very long time charge, and simultaneously does not need to construct the ground charge facility.

(3) Deceleration and recycling of braking energy

When the hybrid electric vehicle decelerates and brakes, the drive motor transforms into the generator, it will change the braking energy into the electrical energy, feeding back to the power battery, causing the deceleration and the braking energy recycled. As is shown in Figure 1(a), the battery supplies the motor power in the normal speed. As is shown in Figure 1(b), the motor charges to the battery as a generator in the deceleration and the braking. As is shown in Figure 1(c), the output and input of the battery electrical energy changes in traveling. Take vehicles' speed as the abscissa, the output and the input of the battery capacity is a y-coordinate. The energy which when the inside common path goes consumes above the abscissa for the electric vehicle, below abscissa for electric vehicle when the inside common path glide and break electric regenerative braking recycling energy

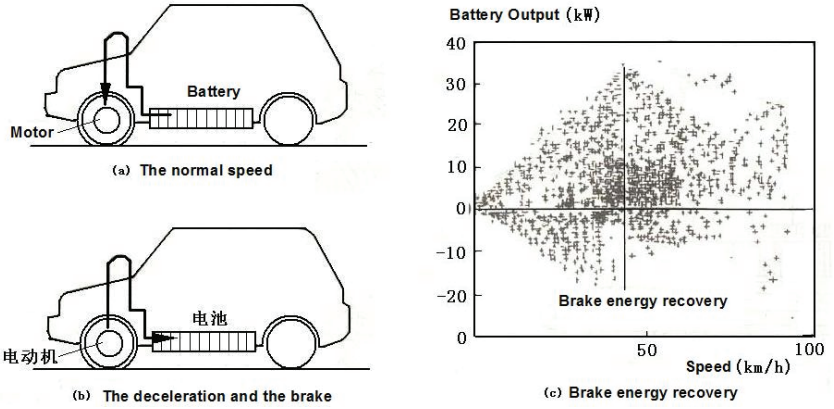

Figure 1. Deceleration and braking energy recovery

3 HEV major technique units

(1) Engine

HEV may use the four stroke regulation internal combustion engine, two stroke internal combustion engines, the rotary engine, the gas turbine and Sterling engine and so on.

(2) Motor

HEV may use the shunt electrical machine, the AC induction electrical machine, permanent magnetism electrical machine and the switched resistance electrical machine and so on. Now, the shunt electrical machine is seldom used while the induction electrical machine and permanent magnetism electrical machine are use widely. The switch magnetic resistance electrical machine application is also used and the special motor as HEV the drive motor is used.

(3) Battery

HEV may use different batteries, fuel cell, energy storer and super capacitor “the battery”, the battery when HEV uses electricity the motive starting engine or the motor auxiliary actuation uses.

4 HEV engine and motor's combination

Because the hybrid electric vehicle's power may be provided by the different type energy and the combination, therefore it varies in the composition and the structure. The hybrid electric vehicle is mainly divided into three kinds:

series (SHEV), parallel (PHEV) and the combined type (PSHEV) according to the energy synthesis's form.

4.1 Series hybrid electric vehicle

The series power consists of the engine, the generator and the motor. The series way which combines SHEV with the power unit system and its structure group prejudice refers to Figure 2. The series hybrid electric vehicle structure is quite simple, the electric drive is its only actuation pattern, between the engine and the car axle the direct solderless joint, the engine has not been possible to work throughout in the expectation operating point, therefore the engine may maintain stable, highly effective, the low pollution running status. But the series hybrid electric vehicle's various parts' power is big, the volume and the quality are also big, therefore the installment arrangement has the very great difficulty, simultaneously, because the energy has experienced from the heat energy to the electrical energy again to the mechanical energy conversion process, the energy loss is big, although engine's fuel oil efficiency is high, but is not high on the entire vehicles fuel oil efficiency. This kind of structure pattern is suitable on the oversize vehicle, specially urban public transportation.

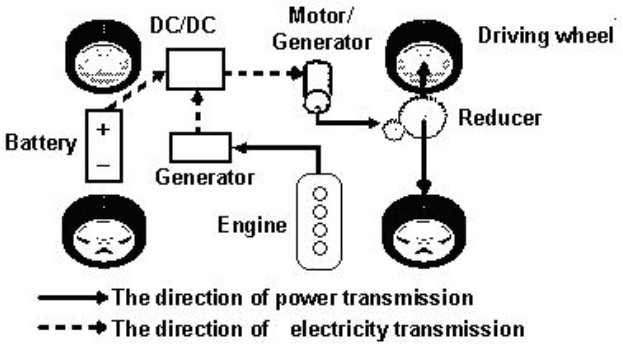

Figure 2. Series Hybrid Electric Vehicle

4.2 Parallel hybrid electric vehicle

The parallel hybrid electric vehicle has two set of driving systems of the engine drive and the electric drive, as shown in Figure 3, both already may drive vehicles and may also actuate the vehicles. The engine also works in the highly effective steady state, the fuel oil efficiency and the emission behavior are quite good. The driving system may choose the parts with the small power, the (ll car.

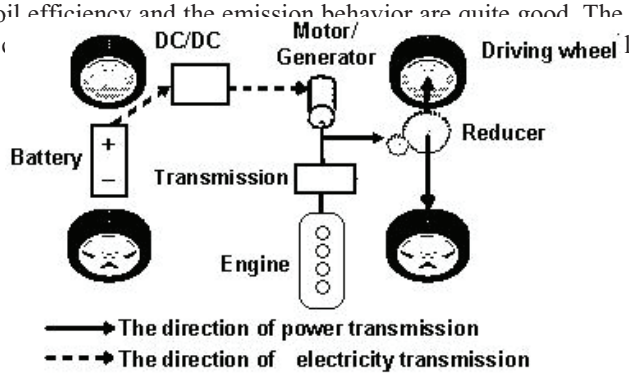

Figure 3 Parallel hybrid electric vehicle

For the parallel engine and the motor by the mechanical energy superimposition's way drive vehicle, the engine and the motor both may drive together or individually. The motor may be used as the motor or the generator, also called the electrically operated-power set. With the independent generator, the engine may directly transmit the power to the wheel through the transmission system actuation, and supply the electrically operated-generator electricity to battery.

4.3 Combined hybrid electric vehicle

For its structure composition of combined hybrid electric vehicle as shown in Figure 4, the major characteristic of the combined hybrid electric dynamic system is that the engine may shut down completely when the automobile starts and travels at the low speed in order to reduce the possible loss of the energy.

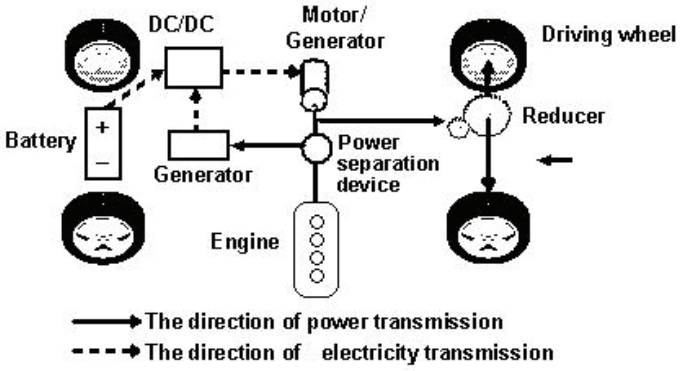

Figure 4 Hybrid electric vehicle

5 Hybrid electric vehicle's actuation pattern

Under controller's function every composition of the hybrid electric vehicle works in coordination within the transmission of the different modes according to driver’s instructions.

5.1 Series hybrid electric vehicle's working pattern

(1) When the vehicle starts, travels or accelerates, the engine and (or) battery both generates the electricity together through the generator and transmits for the converter, then actuation electrically operated-generator, thus through the power transmission actuation wheel. This time, electrically operated-generator works as the motor.

(2) With the light load, engine's output is bigger than driving the power which the wheel requests, the unnecessary electrical energy which the generator produces is used for charging the battery until to the predetermined level of the battery's capacity. This time, electrically operated-generator works as the motor.

(3) In the brake or in the deceleration process, the electrically operated-generator works as the generator, transforming the kinetic energy to the electrical energy of vehicles, and charging the battery through the power converter.

(4) When the vehicle stops, the engine charges the battery through the generator and the power converter.

5.2 Parallel hybrid electric vehicle's working pattern

(1) When the vehicle starts or the throttle is fully open for acceleration, the engine and motor-generator work together to drive the vehicles.

(2) In the normal traveling, the engine provides the essential power to drive the vehicles, but the motor-generator remains disconnected.

(3) When the vehicle decelerates and brakes, the motor-generator works as the generator to charge the battery through the power converter.

(4) When the vehicle is under the light load, the engine provides part of power to the motor-generator to charge the battery through the power converter.

5.3 Combined hybrid electric vehicle's working pattern

(1) When the vehicle starts and the engine is off, the battery works to provide the power which the vehicle needs in

traveling

(2) When the throttle is fully open and the vehicle accelerates in traveling, the engine and the motor-generator work together at the same time and share the power which the vehicle needs in traveling.

(3) When the vehicle travels at the normal speed and the motor shuts down, the engine works to provide the power the vehicle needs.

(4) When the vehicle brakes or decelerates, the motor-generator works in the generator pattern to charge the battery through the power converter.

(5) When the vehicle travels and if the battery needs charging, engine offers part of power to drive the vehicle and another part of power to charge the battery by the generator through the power converter.

(6) When the vehicle stops, the engine may charge the battery through the generator.

6 Conclusion

The hybrid electric vehicle uses the engine and the motor supplementary working pattern when starting or traveling at a low speed. The vehicle only depends upon the electric drive (compound connection type), and this time the engine off, vehicles' fuel oil consumption is a zero. Once starting, the electric motor will arrive at the biggest torque. Or when starting the gasoline engine and the motor work together (series type and parallel), this time the engine is always in the best working field. But the common vehicle's gasoline engine wastes the fuel when starting and saves the fuel only at the ideal speed. Therefore, the engine should work in the best operating condition. These characteristics make the hybrid electric vehicle to be lower than the internal combustion engine vehicle in the fuel consumption and the exhaust emission in the traffic jam. The hybrid electric vehicle is superior to the electric drive vehicle or the pure electric vehicle needed to be charged repeatedly. The hybrid electric vehicle combines the advantages of the internal combustion vehicle and the pure electric vehicle and overcomes their disadvantages. It will be the widely-used energy-saving type of vehicle in the future.

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